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ORIGINAL ARTICLE

Psychological and occupational impact on healthcare workers and its associated factors during the COVID-19 outbreak in China

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Abstract

Purpose China was affected by an outbreak of coronavirus disease 2019 (COVID-19) in 2019–2020. Research data are needed to develop evidence-driven strategies to reduce the adverse psychological and occupational impacts on healthcare workers (HCWs).

Methods From March 1, 2020, to March 8, 2020, 946 HCWs in China completed a survey consist of sociodemographic data, precautionary measures against COVID-19, and concerns about COVID-19. Self-administered questionnaire were collected to assess psychological and occupational adverse outcomes of HCWs. Multivariable logistic regression analysis was performed to identify factors associated with the outcomes.

Results A total of 55.0%, 56.0% and 48.3% of the HCWs experienced burnout, psychological distress and posttraumatic stress, respectively. A total of seven factors were independently associated with burnout: good health status (OR 0.51, 95% CI 0.36–0.71), fear of contagion (OR 1.31, 95% CI 1.003–1.79), avoiding contact with children (OR 1.40, 95% CI 1.03–1.91), enough staff support at the workplace (OR 0.59, 95% CI 0.38–0.92), having to work overtime (OR 1.37, 95% CI 1.03–1.83), maladaptive coping (OR 3.28, 95% CI 2.42–4.45) and adaptive coping (OR 0.47, 95% CI 0.35–0.62). A total of 11 factors were independently associated with high psychological distress: having one child (OR 0.54, 95% CI 0.38–0.77), good health status (OR 0.57, 95% CI 0.39–0.83), alcohol abuse (OR 1.51, 95% CI 1.02–2.25), thinking the epidemic would continue for quite a long time (OR 1.59, 95% CI 1.08–2.34), wearing extra-work clothes (OR 1.51, 95% CI 1.06–2.15),effective protective equipment (OR 0.45, 95% CI 0.22–0.90), enough staff support at the workplace (OR 0.55, 95% CI 0.34–0.89), unable to take care of families (OR 1.99, 95% CI 1.42–2.78), economic losses (OR 1.62, 95% CI 1.14–2.31), maladaptive coping (OR 6.88, 95% CI 4.75–9.97),and adaptive coping (OR 0.29, 95% CI 0.21–0.41). These factors were independently associated with posttraumatic stress: living with the elderly (OR 1.46, 95% CI 1.04–2.05), alcohol abuse (OR 1.41, 95% CI 1.002–1.98), working at a 3A hospital(OR 0.66, 95% CI 0.49–0.88), acquaintances confirmed COVID-19 (OR 2.14, 95% CI 1.20–3.84), fear of contagion (OR 1.87, 95% CI 1.40–2.50), believing they would survive if infected (OR 0.63, 95% CI 0.46–0.86), self-disinfected after arriving home (OR 1.43, 95% CI 1.01–2.02), interpersonal isolation (OR 1.65, 95% CI 1.21–2.26), unable to take care of families (OR 1.41, 95% CI 1.05–1.88) and maladaptive coping (OR 3.09, 95% CI 2.32–4.11).

Conclusion The variance in adverse outcomes was explained by the effect of various factors, which will help policymakers better prepare for subsequent potential outbreaks of COVID-19.

Keywords Epidemic outbreaks · Questionnaire study · Health care staff · Psychologic distress · Burnout · Regression analysis

Introduction

Coronavirus disease 2019 (COVID-19) was first detected in Hubei province in December 2019 and spread with alarming ease across the globe (Wang et al. 2020). Until June 21, 2020, more than 66,729,375 persons in 211 countries and areas had been affected, killing 1,535,982 of them [WHO

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Coronavirus Disease (COVID-19) Dashboard, December 08, 2020]. The COVID-19 crisis was unprecedented in terms of its infectiousness, as it quickly spread to different countries (Zhao et al. 2020). Based on current evidence, the actual route of transmission is still debatable (Huang et al. 2020). The average incubation period is estimated to be 5.2 days, with significant variation among patients, and the longest incubation period was as long as 24 days (Li et al. 2020). Older men with medical comorbidities are more likely to become infected, with worse outcomes (Chen et al. 2020). Asymptomatic spread has also been reported (Chen et al. 2020; Ryu and Chun 2020). The provisional fatality rate by the WHO is approximately 2%, and some researchers estimate the rate to range from 0.3 to 0.6%; however, with the severe overload of medical resources, the fatality rate could skyrocket to over 10% (Nishiura et al. 2020). These characteristics may generally increase perceived risk.

In the affected countries, thousands of HCWs fighting on the frontline have attempted to quell the outbreak, but they are at great risk of contracting COVID-19 from patients. It was reported that 3019 HCWs from 422 medical institutions were infected with COVID-19, and 5 of them died in China as of February 11, 2020 (Epidemiology unit of COVID-19 emergency response mechanism 2020). In some cases, transmission to HCWs occurred even when they were wearing masks, eye protection, gowns and gloves. The ever-increasing number of confirmed and suspected cases, the overwhelming workload, the depletion of the supply of personal protection equipment, the lack of specific drugs, and feelings of being inadequately supported may all contribute to the mental burden of these HCWs. It is likely that HCWs suffer from high levels of associated psychological stress and trauma. Sadly, in countries with severe outbreaks, suicide has been reported among HCWs (Nordt. 2020). Thus, a timely understanding of the mental health status of HCWs is urgently needed (Xiang et al. 2020).

Previous research has revealed a profound and wide range of psychosocial impacts on 19.3–58.6% of HCWs exposed to COVID-19 outbreaks, including high levels of burnout, stress, anxiety, and depression symptoms, which could have long-term implications (Restauri and Sheridan 2020; Salazar de Pablo et al. 2020). Several factors were identified that may have contributed to the distress experienced by HCWs during the epidemic: quarantine, fear of contagion, concern for family, extraordinary infection control precautions, job stress, interpersonal isolation, perceived stigma, and the conscription of non-specialists into infectious workplaces (Maunder et al. 2004; Restauri and Sheridan 2020; Salazar de Pablo et al. 2020). Concerns about the psychological and occupational effects of HCWs working during the COVID-19 outbreak are important, because this work involves the well-being of large numbers of HCWs. Additionally, this information has wider relevance to health systems in planning for emerging infections. To date, some studies have focused on the effect of COVID-19 on the mental health of healthcare workers. However, relatively few studies discussed the public health utility and the transferability of the findings. Our study aimed on providing an evidence-based review and recommendations for systems-based interventions that may reduce physicians' psychological and occupational adverse outcomes.

The study was conducted in early March, towards the end of the epidemic in China, when all healthcare institutions were still on heightened alert. It appears that a clear understanding of the factors that mediate stress in HCWs facing COVID-19 is required to prepare effectively for the ongoing outbreaks of COVID-19 worldwide. This study aimed to assess the psychological and occupational impact of the COVID-19 outbreak on HCWs and to identify the risk and protective factors contributing to adverse outcomes.

Methods

Ethical approval

This study was conducted in accordance with the declaration of Helsinki. Participation was voluntary, and anonymity was assured. Participants were allowed to terminate the survey at any time they desired. The study was ethically approved by HwaMei Hospital, University of Chinese Academy of Sciences (approval number: PJ-NBEY-KY-2020-024-01).

Study participants

We adopted an observational and cross-sectional survey design to assess the HCWs' psychological and occupational response during the epidemic of COVID-19 using an anonymous online questionnaire administered from March 1, 2020, to March 8, 2020. Information about this study was posted on the work bulletin board of HwaMei Hospital, University of Chinese Academy of Sciences, and questionnaires were distributed to all willing HCWs. Participants were also encouraged to pass the questionnaires on to HCWs from other hospitals. HCWs completed the questionnaires through an online survey platform ('SurveyStar', Changsha Ranxing Science and Technology, Shanghai, China). The prevalence of burnout, psychological distress and posttraumatic stress among HCWs were about 55%, 56% and 35%, respectively, according to previous research and our pretest study (Maunder et al. 2006). $N = \frac{Z_{\alpha}^2}{d^2} pq$ was used to calculate sample size ($d = 0.1p$, $\alpha = 0.05$), which showed the minimum sample for burnout, psychological distress and posttraumatic stress study should be 314, 301 and 715, respectively. We increased 20% considering the influence of confounding factors, leading to the minimum

sample size of 855. A total of 1099 HCWs completed the self-report questionnaire and 169 invalid questionnaire (5%) were excluded. Ultimately, this study included 946 HCWs from several provinces.

The questionnaire data

This survey measured sociodemographic data, occupational status, work exposure and quarantine of HCWs. Those worked in COVID-19 wards or fever clinics were defined as frontline workers. We also conducted questions about COVID-19 precautionary measures and concerns about COVID-19: fear of contagion, attitudes and practices with respect to COVID-19, interpersonal isolation, training and support from hospital, workload and impact on personal life.

Simplified Coping Style Questionnaire (SCSQ)

Adaptive coping and maladaptive coping regarding COVID-19 were measured with the relevant subscales of the SCSQ (Liu and Meng 2011). The Cronbach's alpha values for the internal consistency of the use of the SCSQ, the adaptive coping subscale and the maladaptive coping subscale in this study was 0.86, 0.90 and 0.78, respectively.

Impact of Events scale-R (IES-R)

The IES-R (Motlagh 2010) was adapted for use in this study to assess posttraumatic stress disorder symptoms (PTSS) experienced by subjects owing to the COVID-19 outbreak. A score of 20 or more was interpreted to indicate the best diagnostic accuracy of PTSS (Creamer et al. 2003). In this study, Cronbach's alpha was 0.93 for the IES-R.

The exhaustion subscale of the Maslach Burnout Inventory-General Survey (MBI-GS)

The exhaustion (EX) subscale of the MBI-GS was used to measure self-reported burnout by the HCWs. (Schaufeli 2002). In this study, a score of 2 or more was interpreted in this study to indicate burnout (Tomas et al. 2016; Zhu et al. 2016). The Cronbach's alpha for the internal consistency of the use of the EX subscale in this study was 0.947.

Kessler Psychological Distress Scale (K10)

K10 was used to measure the levels of nonspecific psychological distress of the medical staff (Kessler et al. 2002). We used a threshold score of greater than 16 to identify the presence of psychological distress (Maunder et al. 2006; Paice et al. 2002). The Cronbach's alpha of K10 was 0.955.

Statistical analysis

The analysis of the data was conducted in the "table one" package (Version 0.11.1) and "epiDisplay" package (Version 3.5.0.1) of R language version 3.6.1. Specifically, the differences in variables between groups were evaluated using the Pearson Chi-squared test for categorical variables expressed as frequencies (percentages, %) and the Mann–Whitney *U* test for non-normally distributed continuous variables expressed as medians (interquartile ranges, IQRs). Multivariate models were built by incorporating significant variables from Pearson Chi-squared test and Mann–Whitney *U* test in a backward stepwise manner based on the Akaike information criterion (AIC). The effect size is expressed by the odds ratio (OR) value and the 95% confidence interval (CI).

Results

Demographic characteristics

A total of 946 valid questionnaires were analyzed from a total of 1099 eligible participants, giving an effective questionnaire rate of 86%. The majority of respondents were well educated (91.1% ≥ bachelor's degree), were physicians (56.0%), had primary professional title (42.4%). A total of 27.1% of participants worked on the frontline, yet a relatively small portion of the HCWs reported unprotected exposure (2%). Most HCWs (62.6%) were from 3A hospital and 23.7% of them reported alcohol abuse. Other characteristics of study participants are shown in Tables 1 and 2.

Concerns about COVID-19

A total of 43.4% of the HCWs feared being infected by COVID-19, but most of them (71.5%) believed that they would survive if infected. The majority of respondents (77.3%) predicted that the epidemic would continue for quite a long time. HCWs also took practices with respect to the COVID-19 infection such as: wearing an extra-work coat (31.9%), self-disinfect after arriving home (78.1%), avoiding contact with children (32%) and patient (68.5%), some of them even cut work hours (27.8%). The majority of HCWs (ranging from 82.7 to 91.8%) reported adequate training, protection, validated work arrangements and health support by the hospital and society. The work stress of the HCWs during the outbreak of COVID-19 has increased, 57.5% of the HCWs complained that they were unable to take care of their families, and 68.6% suffered economic losses (Table 3).

During the COVID-19 outbreak, HCWs chose several methods to protect themselves and relatives, including but not limited to purchasing one's own personal

Table 1 Sociodemographic factors associated with the adverse outcomes of HCWs during the COVID-19 outbreak

Variables	*N* (%)/median (IQR)	Burnout				Psychological distress				Posttraumactic stress			
		N (%)/median (IQR)		*P**	Adjusted OR[a] (95% CI)	*N* (%)/median (IQR)		*p*	Adjusted OR (95% CI)	*N* (%)/median (IQR)		*p*	Adjusted OR (95% CI)
		Yes	No			Yes	No			Yes	No		
Age (year)	33 (28,39)	32 (28,38)	33 (29,40)	0.069	NA	33 (29, 40)	32 (28, 39)	0.045	NA	33 (29,39)	32 (28,39)	0.207	NA
Gender													
Female	670 (70.8)	367 (54.8)	303 (45.2)	0.853	NA	356 (53.1)	314 (46.9)	0.005	1	323 (48.2)	347 (51.8)	0.924	NA
Male	276 (29.2)	153 (55.4)	123 (44.6)			174 (63.0)	102 (37.0)		1.41 (0.96, 2.07)	134 (44.6)	142 (51.4)		
Ningbo													
No	238 (25.2)	144 (60.5)	94 (39.5)	0.047	NA	150 (63.0)	88 (37.0)	0.012	NA	125 (52.5)	113 (47.5)	0.133	NA
Yes	708 (74.8)	376 (53.1)	332 (46.9)			380 (53.7)	328 (46.3)			332 (46.9)	376 (53.1)		
Education													
High school	84 (8.9)	51 (60.7)	33 (39.3)	0.313	NA	48 (57.1)	36 (42.9)	0.782	NA	42 (5.0)	42 (50.0)	0.162	NA
Bachelor	552 (58.3)	293 (53.1)	259 (46.9)			304 (55.1)	248 (44.9)			279 (50.5)	273 (49.5)		
≥ Master	310 (32.8)	176 (56.8)	134 (43.2)			178 (57.4)	132 (42.6)			136 (43.9)	174 (56.1)		
Religion													
No	822 (86.9)	451 (54.9)	371 (45.1)	0.871	NA	452 (55)	370 (45)	0.098	NA	387 (47.1)	435 (52.9)	0.520	NA
Yes	124 (13.1)	69 (55.6)	55 (44.4)			78 (62.9)	46 (37.1)			70 (56.5)	54 (43.5)		
Marital status													
Unmarried	291 (30.8)	168 (57.7)	123 (42.3)	0.255	NA	166 (57)	125 (43)	0.502	NA	125 (43.0)	166 (57.0)	0.028	NA
Married	655 (69.2)	352 (53.7)	303 (46.3)			364 (55.6)	291 (44.4)			332 (50.7)	323 (49.3)		
Children													
None	365 (38.6)	213 (58.4)	152 (41.6)	0.193	NA	217 (59.5)	148 (40.5)	0.013	1	166 (45.5)	199 (54.5)	0.326	NA
1	453 (47.9)	243 (53.6)	210 (46.4)			232 (51.2)	221 (48.8)		**0.54 (0.38, 0.77)**	224 (49.4)	229 (50.6)		
≥2	128 (12.5)	64 (50)	64 (50)			81 (63.3)	47 (36.7)		0.88 (0.53, 1.47)	67 (52.3)	61 (47.7)		
Live with child ≤ 16 year													
No	535 (56.5)	301 (56.3)	234 (43.7)	0.362	NA	300 (56.1)	235 (43.9)	0.972	NA	250 (46.7)	285 (53.3)	0.267	NA
Yes	411 (43.4)	219 (53.3)	192 (46.7)			230 (56.0)	181 (44.0)			207 (50.4)	204 (49.6)		
Live with the elderly ≥ 65 year													
No	729 (77.1)	389 (53.4)	340 (46.6)	0.069	NA	404 (55.4)	325 (44.6)	0.491	NA	332 (45.5)	397 (54.5)	0.002	1
Yes	217 (22.9)	131 (60.4)	86 (39.6)			126 (58.1)	91 (41.9)			125 (57.6)	92 (42.4)		**1.46 (1.04, 2.05)**
Household income													
Low	266 (28.1)	169 (63.5)	97 (36.5)	0.001	NA	175 (65.8)	91 (34.2)	<0.001	NA	135 (50.8)	131 (49.2)	0.347	NA
Middle or high	680 (71.9)	351 (51.6)	329 (48.4)			355 (52.2)	325 (47.8)			322 (47.4)	358 (52.6)		

Table 1 (continued)

Variables	*N* (%)/median (IQR)	Burnout				Psychological distress				Posttraumactic stress			
		N (%)/median (IQR)		*P**	Adjusted OR[a] (95% CI)	*N* (%)/median (IQR)		*p*	Adjusted OR (95% CI)	*N* (%)/median (IQR)		*p*	Adjusted OR (95% CI)
		Yes	No			Yes	No			Yes	No		
Health status													
Sub-health or unhealthy	265 (28.0)	192 (72.5)	73 (27.5)	< 0.001	1	192 (72.5)	73 (27.5)	< 0.001	1	150 (56.6)	115 (43.4)	0.001	NA
Healthy	681 (72.0)	328 (48.2)	353 (51.8)		**0.51 (0.36, 0.71)**	338 (49.6)	343 (50.4)		**0.57 (0.39, 0.83)**	307 (45.1)	374 (54.9)		
Alcohol abuse													
No	722 (76.3)	368 (51.1)	353 (48.9)	< 0.001	1	368 (51)	354 (49)	< 0.001	1	322 (44.6)	400 (55.4)	< 0.001	1
Yes	224 (23.7)	151 (67.4)	73 (32.6)		1.41 (0.99, 2.00)	162 (72.3)	62 (27.7)		**1.51 (1.02, 2.25)**	135 (60.3)	89 (39.7)		**1.41 (1.002, 1.98)**

Numbers in bold indicated significance of multiple logistic regression analysis

HCW healthcare worker, ||*COVID-19* coronavirus disease 2019, *IQR* inter-quartile range, *OR* odds ratio of multiple logistic regression analysis, *CI* confidence interval, *NA* not applicable

**p*: Pearson Chi-squared test for categorical variables expressed as frequencies (percentages, %) and the Mann–Whitney *U* test for non-normally distributed continuous variables

[a]Risk factors for adverse outcomes identified by multiple logistic regression analysis

protective equipment (PPE) (64.8%). The most common PPE were surgical masks (82.6%) and gloves (64.1%). Advanced PPEs were not reachable for every frontline workers; 62.5% of them were equipped with N95 masks, 49.2% with goggles, 57.4% with face shields, and 79.3% with isolation gowns or protective suits. A total of 60.1% of mask users reported physical discomfort; other issues were also reported, including difficulty communicating (18.0%) or recognizing coworkers (35.3%), a sense of isolation (18.0%) and skin issues (22.1%) (Supplement Table 1).

A majority of respondents considered the accurate COVID-19 information released by state media, specific COVID-19 treatment guidelines and precautionary measures, enough PPE at the workplace and support from relatives would help them better coping with the COVID-19 outbreak. In contrast, inadequate PPE, reported cases of HCW infection or deaths led to HCWs feeling insecure. HCWs also revealed positive aspects of COVID-19 outbreak: 76.4% participants reported an increased awareness of disease control, 14.3% of them felt an increased sense of cooperation (Supplement Table 1).

Severity of measurements and associated factors

A total of 55.0%, 56.0% and 48.3% of the HCWs experienced burnout, psychological distress and posttraumatic stress, respectively. Univariate analysis were conducted to identify the variables significantly associated with burnout, psychological distress and posttraumatic stress separately. Significant variables from univariate analysis were retained for stepwise regression analysis to determine which of these variables accounted for significant variance in each adverse outcome. A total of seven factors were independently associated with burnout: good health status (OR 0.51, 95% CI 0.36–0.71), fear of contagion (OR 1.31, 95% CI 1.003–1.79), avoiding contact with children (OR 1.40, 95% CI 1.03–1.91), enough staff support at the workplace (OR 0.59, 95% CI 0.38–0.92), having to work overtime (OR 1.37, 95% CI 1.03–1.83), maladaptive coping (OR 3.28, 95% CI 2.42–4.45) and adaptive coping (OR 0.47, 95% CI 0.35–0.62). A total of 11 factors were independently associated with high psychological distress: having one child (OR 0.54, 95% CI 0.38–0.77), good health status (OR 0.57, 95% CI 0.39–0.83), alcohol abuse (OR 1.51, 95% CI 1.02–2.25), thinking the epidemic would continue for quite a long time (OR 1.59, 95% CI 1.08–2.34), wearing extra-work clothes (OR 1.51, 95% CI 1.06–2.15), effective protective equipment (OR 0.45, 95% CI 0.22–0.90), enough staff support at the workplace (OR 0.55, 95% CI 0.34–0.89), unable to take care of families (OR 1.99, 95% CI 1.42–2.78), economic losses (OR 1.62, 95% CI 1.14–2.31), maladaptive coping (OR 6.88, 95% CI 4.75–9.97), and adaptive coping (OR 0.29,95% CI 0.21–0.41). These factors were independently

Table 2 Occupational and exposure factors associated with the adverse outcomes of HCWs during the COVID-19 outbreak

Variables	*N* (%)/median (IQR)	Burnout				Psychological distress				Posttraumactic stress			
		N (%)/median (IQR)		*P**	Adjusted OR[a] (95% CI)	*N* (%)/median (IQR)		*p*	Adjusted OR (95% CI)	*N* (%)/median (IQR)		*p*	Adjusted OR (95% CI)
		Yes	No			Yes	No			Yes	No		
Tenure (year)	9 (3,16)	9 (3,15.5)	9 (4,17)	0.232	NA	9 (3, 15)	10 (4, 17)	0.061	NA	10 (4,17)	8 (3,16)	0.059	NA
Clinician													
No	416 (44)	224 (53.8)	192 (46.2)	0.539	NA	218 (52.4)	198 (47.6)	0.047	1	203 (48.8)	213 (51.2)	0.790	NA
Yes	530 (56.0)	296 (55.8)	234 (44.2)			312 (58.9)	218 (41.4)		1.37 (0.96, 1.96)	254 (47.9)	276 (52.1)		
Nurse													
No	674 (71.2)	365 (54.2)	309 (45.8)	0.428	NA	387 (57.4)	287 (42.6)	0.174	NA	326 (48.4)	348 (51.6)	0.954	NA
Yes	272 (28.8)	155 (57.0)	117 (43.0)			143 (52.6)	129 (47.4)			131 (48.2)	141 (51.8)		
Professional title													
Primary	401 (42.4)	225 (56.1)	176 (43.9)	0.801	NA	229 (57.1)	172 (42.9)	0.324	NA	187 (46.6)	214 (53.4)	0.675	NA
Intermediate	350 (37.0)	191 (54.6)	159 (45.4)			201 (57.4)	149 (42.6)			173 (49.4)	177 (50.6)		
Senior	195 (20.6)	104 (53.5)	91 (46.7)			100 (51.3)	95 (48.7)			97 (49.7)	98 (50.3)		
Permanent staff													
No	214 (22.6)	127 (59.3)	87 (40.7)	0.143	NA	132 (61.7)	82 (38.3)	0.058	NA	110 (51.4)	104 (48.6)	0.303	NA
Yes	732 (77.4)	393 (53.7)	339 (46.3)			398 (54.4)	334 (45.6)			347 (47.4)	385 (52.6)		
Hospital level													
Not 3A	354 (37.4)	204 (57.6)	150 (42.4)	0.204	NA	208 (58.8)	146 (41.2)	0.191	NA	192 (54.2)	162 (45.8)	0.005	1
3A	592 (62.6)	316 (53.4)	276 (46.6)			322 (54.4)	270 (45.6)			265 (44.8)	327 (55.2)		**0.66 (0.49, 0.88)**
Commute plan													
Walk	640 (67.7)	347 (54.2)	293 (45.8)	0.503	NA	367 (57.3)	273 (42.7)	0.237	NA	311 (48.6)	329 (51.4)	0.800	NA
Others	306 (32.3)	173 (56.5)	133 (43.5)			163 (53.3)	143 (46.7)			146 (47.7)	160 (52.3)		
Experience medical disputes													
No	783 (82.8)	415 (53.0)	368 (47.0)	0.008	NA	425 (54.3)	358 (45.7)	0.018	NA	367 (46.9)	416 (53.1)	0.052	NA
Yes	163 (17.2)	105 (64.4)	58 (35.6)			105 (64.4)	58 (35.6)			90 (55.2)	73 (44.8)		
Worked on frontline													
None	690 (72.9)	368 (53.3)	322 (46.7)	0.386	NA	375 (54.3)	315 (45.7)	0.093	NA	327 (47.4)	363 (52.6)	0.201	NA
≤2 week	86 (9.1)	53 (61.6)	33 (38.4)			59 (68.6)	27 (31.4)			51 (59.3)	35 (40.7)		
2–4 weeks	78 (8.2)	45 (57.7)	33 (42.3)			45 (57.7)	33 (42.3)			36 (46.2)	42 (53.8)		
≥4 weeks	92 (9.7)	54 (58.7)	38 (41.3)			51 (55.4)	41 (44.6)			43 (46.7)	49 (53.3)		
Unprotected exposure													
No	927 (98)	508 (54.8)	419 (45.2)	0.469	NA	513 (55.3)	414 (44.7)	0.003	1	443 (47.8)	484 (52.2)	0.025	NA
Yes	19 (2)	12 (63.2)	7 (36.8)			17 (89.5)	2 (10.5)		6.05 (0.96, 38.13)	14 (73.7)	5 (26.3)		
In COVID-19 patient's room > 5 min													
No	889 (94.0)	487 (54.8)	402 (45.2)	0.647	NA	495 (55.7)	394 (44.3)	0.399	NA	428 (48.1)	461 (51.9)	0.689	NA
Yes	57 (6.0)	33 (57.9)	24 (42.1)			35 (61.4)	22 (38.6)			29 (50.9)	28 (49.1)		

Table 2 (continued)

Variables	*N* (%)/median (IQR)	Burnout				Psychological distress				Posttraumactic stress			
		N (%)/median (IQR)		*P**	Adjusted OR[a] (95% CI)	*N* (%)/median (IQR)		*p*	Adjusted OR (95% CI)	*N* (%)/median (IQR)		*p*	Adjusted OR (95% CI)
		Yes	No			Yes	No			Yes	No		
In COVID-19 patient's room > 5 times													
No	897 (94.8)	489 (54.5)	408 (45.5)	0.231	NA	501 (55.9)	396 (44.1)	0.647	NA	433 (48.3)	464 (51.7)	0.923	NA
Yes	49 (5.2)	31 (63.3)	18 (36.7)			29 (59.2)	20 (40.8)			24 (49.0)	25 (51.0)		
Quarantined													
No	839 (88.7)	454 (54.1)	385 (45.9)	0.138	NA	466 (55.5)	373 (44.5)	0.402	NA	400 (47.7)	439 (52.3)	0.275	NA
Yes	107 (11.3)	66 (61.7)	41 (38.3)			64 (59.8)	43 (40.2)			57 (53.3)	50 (46.7)		
Acquaintances confirmed COVID-19													
No	882 (93.2)	480 (54.4)	402 (45.6)	0.210	NA	486 (55.1)	396 (44.9)	0.034		415 (47.1)	467 (52.9)	0.004	1
Yes	64 (6.7)	40 (62.5)	24 (37.5)			44 (68.8)	20 (31.3)		NA	42 (65.6)	22 (34.4)		**2.14 (1.20, 3.84)**

Numbers in bold indicated significance of multiple logistic regression analysis

HCW healthcare worker, ‖*COVID-19* coronavirus disease 2019, *IQR* inter-quartile range, *OR* odds ratio of multiple logistic regression analysis, *CI* confidence interval, *NA* not applicable

*p: Pearson Chi-squared test for categorical variables expressed as frequencies (percentages, %) and the Mann–Whitney U test for non-normally distributed continuous variables

[a]Risk factors for adverse outcomes identified by multiple logistic regression analysis

associated with posttraumatic stress: living with the elderly (OR 1.46, 95% CI 1.04–2.05), alcohol abuse (OR 1.41, 95% CI 1.002–1.98), working at a 3A hospital (OR 0.66, 95% CI 0.49–0.88),acquaintances confirmed COVID-19 (OR 2.14, 95% CI 1.20–3.84), fear of contagion (OR 1.87, 95% CI 1.40–2.50), believing they would survive if infected (OR 0.63, 95% CI 0.46–0.86), self-disinfected after arriving home (OR 1.43, 95% CI 1.01–2.02), interpersonal isolation (OR 1.65, 95% CI 1.21–2.26), unable to take care of families (OR 1.41, 95% CI 1.05–1.88) and maladaptive coping (OR 3.09, 95% CI 2.32–4.11). The results are shown in Tables 1, 2 and 3.

Discussion

This cross-sectional survey enrolled 946 respondents and about half of the HCWs reported burnout, psychological distress or posttraumatic stress during the COVID-19 outbreak. Our results were similar to previously studies which revealed high rates of symptoms of burnout (19.3–53.5%), psychological distress (28.4–56.6%) and posttraumatic stress (13.2–58.6%) in the in HCWs during the pandemic (Salazar de Pablo et al. 2020).The evaluation of mediating factors suggested that systemic, individual and occupational factors were associated with the adverse psychological and occupational effects of the COVID-19 outbreak. These findings could be framed in terms of their potential value for the future, and we want to learn from the COVID-19 experience in China to try to buffer this negative impact.

Health authorities need to identify high-risk groups of HCWs based on sociodemographic information for early psychological interventions. Our sociodemographic data suggested that HCWs had one child were more likely to exhibit reduced psychological distress. Multivariable logistic regression analysis showed that HCWs who lived with elderly adults during the outbreak reported greater posttraumatic stress. We attribute this to the fact that the HCWs were worried about transmitting COVID-19 to the elderly, who were more likely to become infected by COVID-19 and had worse outcomes (Chen et al. 2020). The results of our study suggested that temporary separation between HCWs and the elderly adults during the outbreak of COVID-19 (but frequent communication online) may be helpful in reducing the adverse effects. Providing effective family support for healthcare workers may help to minimize the adverse mental health issues among HCWs during epidemic. We also found that HCWs with a poor health status were significantly associated with psychological distress, indicating the importance of maintaining one's daily health status in the face of major infectious diseases. Hospital administrators should consider health status of HCWs when assigning work during the COVID-19 outbreak. In this study, HCWs with

Table 3 Association between the concerns and coping style of COVID-19 and the adverse outcomes of HCWs during the COVID-19‖ outbreak

Variables	*N* (%)/Median (IQR)	Burnout				Psychological distress				Psychological distress			
		N (%)/Median (IQR)		*P**	Adjusted OR[a] (95% CI)	*N* (%)/Median (IQR)		*p*	Adjusted OR (95% CI)	*N* (%)/Median (IQR)		*p*	Adjusted OR (95% CI)
		Yes	No			Yes	No			Yes	No		
Fear of contagion													
No	535 (56.6)	260 (48.6)	275 (51.4)	< 0.001	1	254 (47.5)	281 (52.5)	< 0.001	1	212 (39.6)	323 (60.4)	< 0.001	1
Yes	411 (43.4)	260 (63.3)	151 (36.7)		**1.34 (1.003, 1.79)**	276 (67.2)	135 (32.8)		1.36 (0.98, 1.89)	245 (59.6)	166 (40.4)		**1.87 (1.40, 2.50)**
I think the epidemic would continue for quite a long time													
No	215 (22.7)	99 (46.0)	116 (54.0)	0.003	NA	92 (42.8)	123 (57.2)	< 0.001	1	88(40.9)	127(59.1)	0.014	NA
Yes	731 (77.3)	421 (57.6)	310 (42.4)			438 (59.9)	293 (40.1)		**1.59(1.08, 2.34)**	369(50.5)	362(49.5)		
I believe my chance of dying from COVID-19 is low													
No	270 (28.5)	166 (61.5)	104 (38.5)	0.011	NA	174 (64.4)	96 (35.6)	< 0.001	1	158 (58.5)	112 (41.5)	< 0.001	1
Yes	676 (71.5)	354 (52.4)	322 (47.6)			356 (52.7)	320 (47.3)		0.73 (0.51, 1.05)	299 (44.2)	377 (55.8)		**0.63 (0.46, 0.86)**
Wear extra-work clothes													
No	644 (68.1)	351 (54.5)	293 (45.5)	0.675	NA	340 (52.8)	304 (47.2)	0.003	1	297 (46.1)	347 (53.9)	0.049	NA
Yes	302 (31.9)	169 (56.0)	133 (44.0)			190 (62.9)	112 (37.1)		**1.51 (1.06, 2.15)**	160 (53.0)	142 (47.0)		
Self-disinfect after arriving home													
No	207 (21.9)	121 (58.5)	86 (41.5)	0.254	NA	115 (55.6)	92 (44.4)	0.878	NA	82 (39.6)	125 (60.4)	0.005	1
Yes	739 (78.1)	399 (54.0)	340 (46.0)			415 (56.2)	324 (43.8)			375 (50.7)	364 (49.3)		**1.43 (1.01, 2.02)**
Avoid contact with children													
No	643 (78.0)	331 (51.5)	312 (48.5)	0.002	1	337 (52.4)	306 (47.6)	0.001	NA	292 (45.4)	351 (54.6)	0.009	NA
Yes	303 (32.0)	189 (62.4)	114 (37.6)		**1.40 (1.03, 1.91)**	193 (63.7)	110 (36.3)			165 (54.5)	138(45.5)		
Avoid contact with patient													
No	298 (31.5)	162 (54.4)	136 (45.6)	0.799	NA	150 (50.3)	148 (49.7)	0.017	NA	127 (42.6)	171 (57.4)	0.018	NA
Yes	648 (68.5)	358 (55.2)	290 (44.8)			380 (58.6)	268 (41.4)			330 (50.9)	318 (49.1)		
Reduce work hours													
No	683 (72.4)	359 (52.6)	324 (47.4)	0.017	NA	354 (51.8)	329 (48.2)	< 0.001	NA	315(46.1)	368 (53.9)	0.030	NA
Yes	263 (27.8)	161 (61.2)	102 (38.8)			176 (66.9)	87 (33.1)			142 (54.0)	121 (46.0)		
Interpersonal isolation													
No	653 (69.0)	332 (50.8)	321 (49.2)	< 0.001	NA	326 (49.9)	327 (50.1)	< 0.001	1	278 (42.6)	375 (57.4)	< 0.001	1
Yes	293 (31.0)	188 (64.2)	105 (35.8)			204 (69.6)	89 (30.4)		1.42 (0.98, 2.05)	179 (61.1)	114 (38.9)		**1.65 (1.21, 2.26)**

Table 3 (continued)

Variables	*N* (%)/Median (IQR)	Burnout				Psychological distress				Psychological distress			
		N (%)/Median (IQR)		*P**	Adjusted OR[a] (95% CI)	*N* (%)/Median (IQR)		*p*	Adjusted OR (95% CI)	*N* (%)/Median (IQR)		*p*	Adjusted OR (95% CI)
		Yes	No			Yes	No			Yes	No		
I feel appreciated by society													
No	66 (7.0)	49 (74.2)	17 (25.8)	0.001	NA	50 (75.8)	16 (24.2)	0.001	NA	35 (53.0)	31 (47.0)	0.426	NA
Yes	880 (93.0)	471 (53.5)	409 (46.5)			480 (54.5)	400 (45.5)			422 (48.0)	458 (52.0)		
I received adequate training													
No	131 (13.8)	99 (75.6)	32 (24.4)	< 0.001	1	102 (77.9)	29 (22.1)	< 0.001	NA	76 (58.0)	55 (42.0)	0.017	NA
Yes	815 (86.2)	421 (51.7)	394 (48.3)		0.65 (0.40, 1.04)	428 (52.5)	387 (47.5)			381 (46.7)	434 (53.3)		
My protection is effective													
No	79 (8.4)	59 (74.7)	20 (25.3)	< 0.001	NA	65 (82.3)	14 (17.7)	< 0.001	1	48 (60.8)	31 (39.2)	0.021	NA
Yes	867 (91.6)	461 (53.2)	406 (45.0)			465 (53.6)	402 (46.4)		**0.45 (0.22, 0.90)**	409 (47.2)	458 (52.8)		
Instant and clear policies and protocols were instituted													
No	54 (5.7)	41 (75.9)	13 (24.1)	0.001	NA	43 (79.6)	11 (20.4)	< 0.001	NA	29 (53.7)	25 (46.3)	0.414	NA
Yes	892 (94.3)	479 (53.7)	413 (46.3)			487 (48.6)	405 (45.4)			428 (48.0)	464 (52.0)		
My hospital considered my well-being when assigning work													
No	106 (11.2)	81 (76.4)	25 (23.6)	< 0.001	NA	84 (79.2)	22 (20.8)	< 0.001	NA	66 (62.3)	40 (37.7)	0.002	NA
Yes	840 (88.8)	439 (52.3)	401 (47.7)			446 (53.1)	394 (46.9)			391 (46.5)	449 (53.5)		
I am confident my employer would look after my medical needs if I got COVID-19													
No	78 (8.2)	59 (75.6)	19 (24.4)	< 0.001	NA	63 (80.8)	15 (19.2)	< 0.001	NA	41 (52.6)	37 (47.4)	0.432	NA
Yes	868 (91.8)	461 (53.1)	407 (46.9)			467 (53.8)	401 (46.2)			416 (47.9)	452 (52.1)		
Enough staff support at the workplace													
No	164 (17.3)	124 (75.6)	40 (24.4)	< 0.001	1	129 (78.7)	35 (21.3)	< 0.001	1	97 (59.1)	67 (40.9)	0.002	NA
Yes	782 (82.7)	396 (50.6)	386 (49.4)		**0.59 (0.38, 0.92)**	401 (51.3)	381 (48.7)		**0.55 (0.34, 0.89)**	360 (46.0)	422 (54.0)		
I had to work overtime													
No	436 (46.0)	220 (50.5)	216 (49.5)	0.010	1	230 (52.8)	206 (47.2)	0.061	NA	182 (41.7)	254 (58.3)	< 0.001	
Yes	510 (54.0)	300 (58.8)	210 (41.2)		**1.37 (1.03, 1.83)**	300 (58.8)	210 (41.2)			275 (53.9)	235 (46.1)		
I had to do work that normally I don't do													
No	237 (25.1)	114 (48.1)	123 (51.9)	0.014	NA	125 (52.7)	112 (47.3)	0.24	NA	93 (39.2)	144 (60.8)	0.001	NA
Yes	709 (74.9)	406 (57.3)	303 (42.7)			405 (57.1)	304 (42.9)			364 (51.3)	345 (48.7)		
Unable to take care of families													
No	402 (42.5)	196 (48.8)	206 (51.2)	0.001	NA	185 (45.8)	218 (54.2)	< 0.001	1	161 (40.0)	241 (60.0)	< 0.001	1
Yes	544 (57.5)	324 (59.6)	220 (40.4)			346 (63.6)	198 (36.4)		**1.99 (1.42, 2.78)**	296 (54.4)	248 (45.6)		**1.41 (1.05, 1.88)**

Table 3 (continued)

Variables	*N* (%)/Median (IQR)	Burnout		*P**	Adjusted OR[a] (95% CI)	Psychological distress		*p*	Adjusted OR (95% CI)	Psychological distress		*p*	Adjusted OR (95% CI)
		N (%)/Median (IQR)				*N* (%)/Median (IQR)				*N* (%)/Median (IQR)			
		Yes	No			Yes	No			Yes	No		
Economic loss													
No	297 (31.4)	139 (46.8)	158 (53.2)	0.001	NA	121 (40.7)	176 (59.3)	< 0.001	1	114 (38.4)	183 (61.6)	< 0.001	NA
Yes	649 (68.6)	381 (58.7)	268 (41.3)			409 (63.0)	240 (37.0)		**1.62 (1.14, 2.31)**	343 (52.9)	306 (47.1)		
Adaptive coping	1.9 (1.6,2.3)	1.8 (1.5,2.1)	2.0 (1.7,2.3)	< 0.001	**0.47 (0.35,0.62)**	1.8 (1.5,2.1)	2.0 (1.7,2.4)	< 0.001	**0.29 (0.21, 0.41)**	1.9 (1.5,2.3)	1.9 (1.6,2.2)	0.510	NA
Maladaptive coping	1.1 (0.8,1.5)	1.3 (0.9–1.6)	0.9 (0.6–1.3)	< 0.001	**3.28 (2.42, 4.45)**	1.3 (1.0,1.6)	0.9 (0.5,1.1)	< 0.001	**6.88 (4.75, 9.97)**	1.3 (1.0,1.6)	0.9 (0.6,1.3)	< 0.001	**3.09 (2.32, 4.11)**

Numbers in bold indicated significance of multiple logistic regression analysis

HCW healthcare worker, ‖*COVID-19* coronavirus disease 2019, *IQR* inter-quartile range, *OR* odds ratio of multiple logistic regression analysis, *CI* confidence interval, *NA* not applicable

**p*: Pearson Chi-squared test for categorical variables expressed as frequencies (percentages, %) and the Mann–Whitney *U* test for non-normally distributed continuous variables

[a]Risk factors for adverse outcomes identified by multiple logistic regression analysis

alcohol abuse were significantly associated with higher risk of psychological distress and posttraumatic stress. HCWs suffering from alcohol abuse may pose a risk for the health and safety of themselves. The occupational health specialist charged of medical surveillance of hospital workers need to recognize HCWs suffering from alcohol abuse and define effective strategies to deal with the problem such as transfer from frontline work.

)Occupational factors often have an effect on psychological outcomes. Hospital level was the factor strongly associated with posttraumatic stress. HCWs worked at 3A hospital exhibited reduced posttraumatic stress. We attribute this to HCWs worked at 3A hospital were more likely to have experience to deal with disasters and public infectious events, and most of them had lower economic stress. Currently, with the increase in the number of cases of COVID-19 infection in China, frontline medical staff were required to wear protective masks and protective clothing. Many participants expressed discomfort in using PPE, especially wearing masks and isolation suits, as a highly intense shift in PPE may cause feelings of suffocation and dehydration, not to mention inconveniences with respect to urination and defecation, all of which may cause added stress. However, discomfort is incomparable to safety, and a shortage of PPE for frontline workers is realistic. In addition to isolation wards and fever clinics, personnel working in other departments may also contact COVID-19 patients, but special PPEs such as N95 mask were not provided to them by medical authorities. The protective effect of the PPEs were also doubted, as a portion of the PPE provided to hospital were not for medical use, some cautious HCWs chose to wear extra-work clothes, which would aggravate psychological distress according to our result. Cases of infection and death among HCWs were still reported in some hospitals, which may enhance the insecurity of HCWs, while providing enough and effective PPEs was an easy way to give HCWs security (Epidemiology Working Group for Ncip Epidemic Response and Prevention 2020). Great efforts should be made to access to abundant PPEs, including receiving donation from society, government's coordination, and medical supplies manufacturing increase.

Perceptions of risk of infection are easily understood due to COVID-19's preferential transmission to hospital workers and its substantial mortality. With the increasing reported cases of HCWs and acquaintances infection or deaths, HCWs experienced fear of getting infected, and these were significantly associated with psychological distress. HCWs feared of contagion were more likely to exhibit reduced work efficiencies and were significantly associated with burnout. Some of the HCWs predicted the epidemic would continue for quite a long time, which was the predictors of high psychological distress. Most HCWs believe they would survive if infected, which was strongly associated

with lower posttraumatic stress. Professional psychotherapy teams should be established to support the mental health of medical staff and provide individually targeted interventions, especially for HCWs who experienced acquaintances infected or died from COVID-19. A more supportive social environment and more friendly mass media would be helpful to HCWs psychological health during an infectious disease outbreak. In China, there was a timely data in open to provide people with dynamic and important information so that they could fully understand the pandemic and policies; hospitals organized periodically training system to help HCWs updating knowledge of COVID-19. These would be helpful to reduce HCWs' fear of the uncontrollable future and reduce adverse psychological and occupational effects of the COVID-19 outbreak.

Most HCWs disinfected themselves as soon as they arrived home and some of them avoided contacting with children not to passing the virus on to their family members, which were significantly associated with burnout and posttraumatic stress. During January to March, when the outbreak was hardly under control, instead of returning home, most frontline workers were accommodated in designated hotels or dormitory, which may alleviate their concern. Most of the HCWs reported that there were adequate staff at their workplace to handle the different demands, which were independently associated with decreased burnout and psychological distress. Social isolation in infectious diseases was related to the threat of infection and reduced contact and may be a stress-provoking feature (Hall et al. 2003). Our study suggested that interpersonal isolation provoked psychological distress. Efforts to reduce the negative impact of interpersonal isolation could include creative efforts to increase effective interpersonal communication, such as web-based support or discussion groups.

Job-related stressors during the COVID-19 crisis included increased workload and a lack of control over work, including involuntary conscription. The study showed that working overtime was a significant predictor of burnout. Therefore, it is important to attend to organizational characteristics that are known to buffer burnout during the prepandemic period, which include reducing patient-to-HCW ratios, arranging HCWs' work and rest schedules reasonably and increasing perceived empowerment (Laschinger et al. 2001). An inability to take care of their family was the independent predictive factor of posttraumatic stress and psychological distress. Personal economic losses were significantly associated with psychological distress. In China, most frontline workers were transferred from other department after detailed pre-training, whose work time was no more than a month. Substantial subsidy was leaned to HCWs especially the frontline workers in China during the pandemic. Preference to the frontline workers was rewarded in professional title promotion. These supportive interventions such as increased incomes and reasonable work and rest schedules for two-worker households may be useful for HCWs.

Maladaptive coping was a strong independent risk factor for worse mental health and occupational outcomes in all dimensions of interest. Adaptive coping could significantly reduce psychological distress and burnout. According to previous studies, social support contributes to improving self-efficacy, leading to a sense of professional achievement, which improves coping mechanisms under stress (Glozah 2015; Meixia et al. 2016). For example, hostile confrontation and self-blame may be reduced in a work environment that fosters positive working relationships through effective leadership (Yank et al. 1992). It is important to encourage staff to plan for future outbreaks, reducing the tendency to cope by means of avoidant strategies and enhancing coping through problem solving and peer support. Programs directed towards healthy lifestyles, diet, exercise, and smoking cessation may also be important in providing support to staff.

After the outbreak, China tried to adopt a thorough prevention measures in an attempt to bring the virus under control. Individuals could apply or download a health QR codes in three colors—green, yellow and red—indicating different risks to serve as permits for hospital safety. Designated hospitals were organized for treatment of confirmed patients and HCWs were recruited from different departments, which would be helpful to prevent collapse of the health systems. When the lessons of COVID-19 in China applied to other affected countries, effective protection, training and support may be a primary target to bolster the resilience of HCWs who will face future outbreaks. The State Council also issued a notice to strengthen psychological crisis interventions and psychological counseling for healthcare workers. Mental health psychological centers set up psychological consultation platforms, developed psychological intervention plans, and offered remote psychological interventions to provide psychological assistance for healthcare workers.

Positive aspects of the COVID-19 outbreak were also reported. Most of the staff noted an increased awareness and experience of infection control. The majority of HCWs reported treasuring life and work more. It may be useful for preparatory training packages and interventions to encourage healthcare workers focusing on the potential positive impact of their work or considering coping strategies that may help them to see the positive effects of working in a crisis.

This study has several limitations. The most significant methodological limitation of this study was that we use subjective self-reported questionnaires online to obtain the data, which was not based on a random selection of the sample, and the study population might not reflect the actual patterns of the general population. Nonetheless, our results must be interpreted conservatively. Among the study's limitations were its small sample size, and cohort studies with larger

samples are needed to investigate the psychological and occupational impact of COVID-19 outbreaks on HCWs. A further limitation is that self-reports of COVID-19 experiences do not provide an objective evaluation of actual differences in the training, protection, or support that HCWs received. Regardless of the limitations, the Impact of the COVID-19 Study provides a window to the long-term effects of working during times of extraordinary infectious risk.

Our findings demonstrate a significant adverse psychosocial and occupational impact of the COVID-19 outbreak in China on HCWs. The findings from this study may provide support for the implementation of measures to improve the social support of medical staff during increased demands associated with COVID-19 outbreak at this time. Future follow-up investigations using both qualitative and quantitative approaches will be necessary to understand the psychosocial effects of COVID-19 on HCWs over time.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00420-021-01657-3.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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